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Mr. Bryan Foley
U.S. DOE- Richland Operations Office
P.O. BOX 550
Richland, WA 99352

FEB 1999 RECEIVED

COMMENTS ON THE 200 AREA RI/FS STUDY IMPLEMENTATION PLAN

Dear Mr. Foley:

Geosafe Corporation submits the following comments in regard to the 200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program, DOE/RL-98-28 Draft B request for public comment. Geosafe has limited its comments to only Appendix D of this report. Appendix D provides a preliminary list of technologies which may be applicable to the remediation of the 200 Area sites. Geosafe's comments are all related to the discussion of the In Situ Vitrification (ISV) technology for which we are the sole licensed commercial provider. 49972

Geosafe's comments are as follows:

1) Pg. D-10, Sec. D5.6, 3rd para.- Replace "encapsulates contaminants" with "chemically incorporates most inorganics (including heavy metals and radionuclides) and destroys or removes all organic contaminants". Delete "The process combines thermal treatment with stabilization.". Replace "process depths are limited to less than 6 m" with "process depths are limited to 6 m with existing equipment but deeper depths are possible. Melts may also be started at depths in the subsurface.".

2) Pg. D-17, Sec. D6.6, 1st para.- Replace "A large fume hood would be constructed over the site before the start of the vitrification process to collect and treat emissions." with "An off-gas hood would be placed over the area to be treated. Gases generated during vitrification operations are collected in the off-gas hood and processed by an off-gas treatment system before being discharged. During vitrification operations, a large volume reduction will occur resulting in an estimated 2 m of ground subsidence. This subsidence volume can be filled with clean fill material thereby minimizing the potential for inadvertent human or animal contact with the monolith.".

3) Pg. D-18, Sec D6.6, 2nd para.- Replace "However this alternative would not reduce the mass or toxicity of the radionuclides present onsite" with "This alternative would

eliminate the hazardous characteristics of the waste being treated and would result in radionuclides being incorporated in a durable leach resistant vitrified product having a useful life measured in the thousands of years."

4) Pg. D-21, Sec D 6.7, 4th para.- Replace ", but is not considered a fully mature technology due to a limited experience base" with ". The In Situ Vitrification technology has undergone extensive commercial development in the last four years and has been successfully applied to the treatment of over 20,000 tons of soil contaminated with hazardous constituents and 4,000 tons of mixed-TRU contaminated soil and debris."

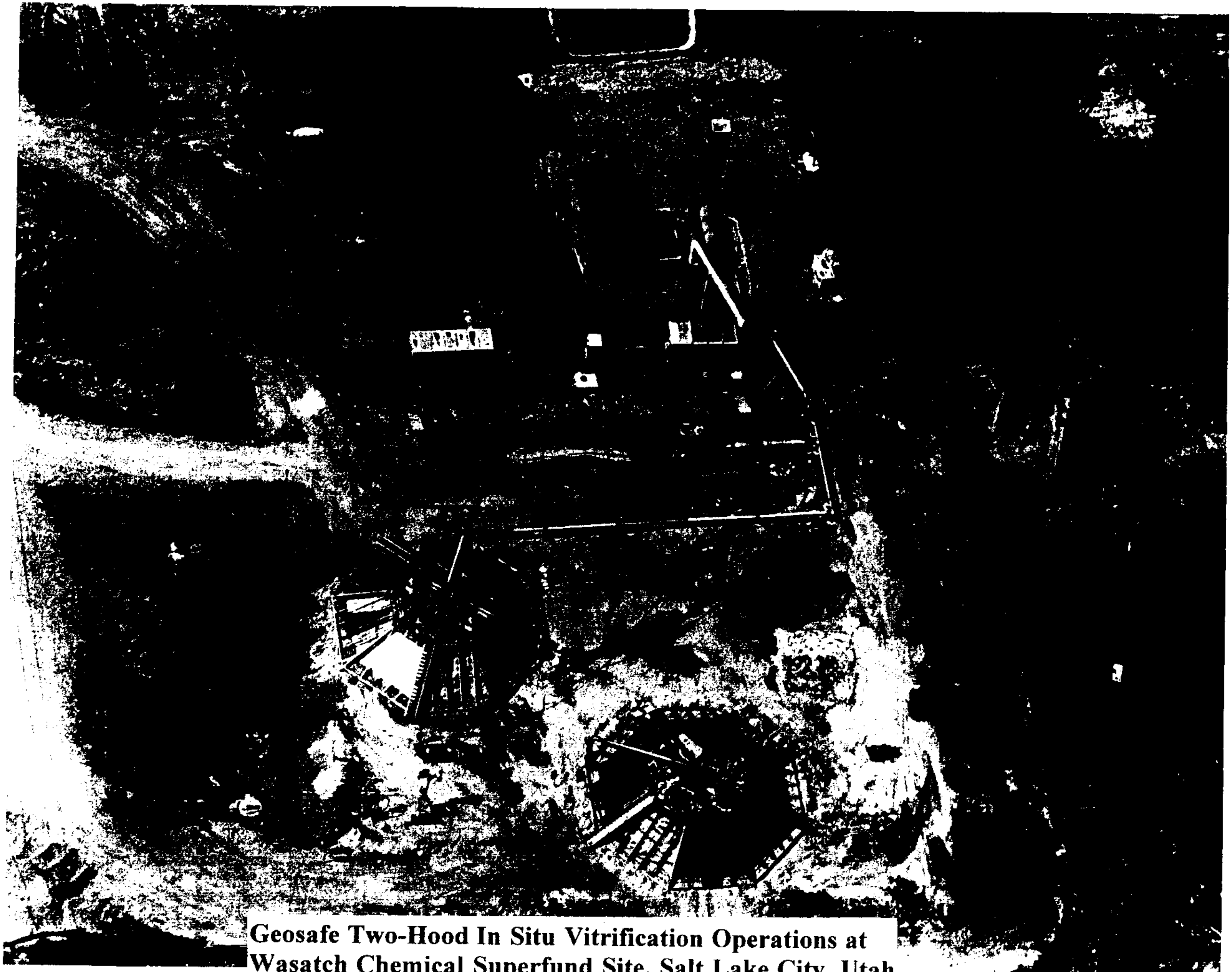
If you have any question concerning these comments, please contact me or Mr. Jim Hansen at (509) 375-0710.

Sincerely,

GEOSAFE CORPORATION

Matthew J. Haass

Matthew J. Haass, P.E.
Senior Project & Business Development Engineer



Geosafe Two-Hood In Situ Vitrification Operations at Wasatch Chemical Superfund Site, Salt Lake City, Utah

GeoMelt™ Vitrification Technologies Fact Sheet

GeoMelt Description

Geosafe Corporation's GeoMelt technologies are a family of vitrification technologies that are being commercially applied for site remediation and waste treatment needs. GeoMelt vitrification is based on the original in situ vitrification (ISV) technology developed by Battelle for the U.S. Department of Energy (DOE) in the 1980s.

The GeoMelt family consists of two methods of melting and four processing configurations. The melting methods are **top-down** melting and **planar** melting. The processing configurations are 1) **GeoMelt-ISV** for in situ applications, 2) **GeoMelt-Staged ISV** for treating materials that have been staged for processing, 3) **GeoMelt-Stationary Batch** for repetitive melt cycling at a single location, and 4) **GeoMelt-Continuous** for material feeding and melt withdrawal at a stationary facility. (See p. 4 for a description of these configurations, their features, and benefits.)

GeoMelt remediates contaminated soil, sediment, sludge, mill tailings, and other earthen materials containing hazardous and/or radioactive contaminants. GeoMelt also has a high tolerance for debris (e.g., wood, scrap metal, concrete, boulders, asphalt, plastics, tires, or vegetation) that might be in the treatment area.

The GeoMelt Process

The GeoMelt process and equipment system is shown in Figure 1. The process works by melting soil in place using electricity applied between pairs of graphite electrodes. A highly conductive starter path is placed between the electrodes to allow melting to begin. As electricity flows through the starter path, the path heats up and causes the surrounding media to melt. Once the media is molten, it too becomes electrically conductive. Continued application of electricity results in joule heating within the molten media between the electrodes. After the melt is fully established, the melt zone grows steadily downward and outward through the contaminated volume.

The media being treated must be capable of forming a melt with adequate electrical conductivity. Most natural soils and other earthen materials meet this criteria and can be processed without modification. If necessary, additives can be used to allow treatment of otherwise unacceptable media.

GeoMelt is one of the few technologies that can simultaneously treat wastes with high concentrations of both organic and inorganic (heavy metal) contaminants. Most of the organic and some of the inorganic compounds are destroyed by thermally induced decomposition (pyrolysis) in the oxygen-depleted environment in and around the melt zone. Volatile components travel to the surface of the melt where they are oxidized. Any contaminants in the off-gases are treated by the off-gas treatment system.

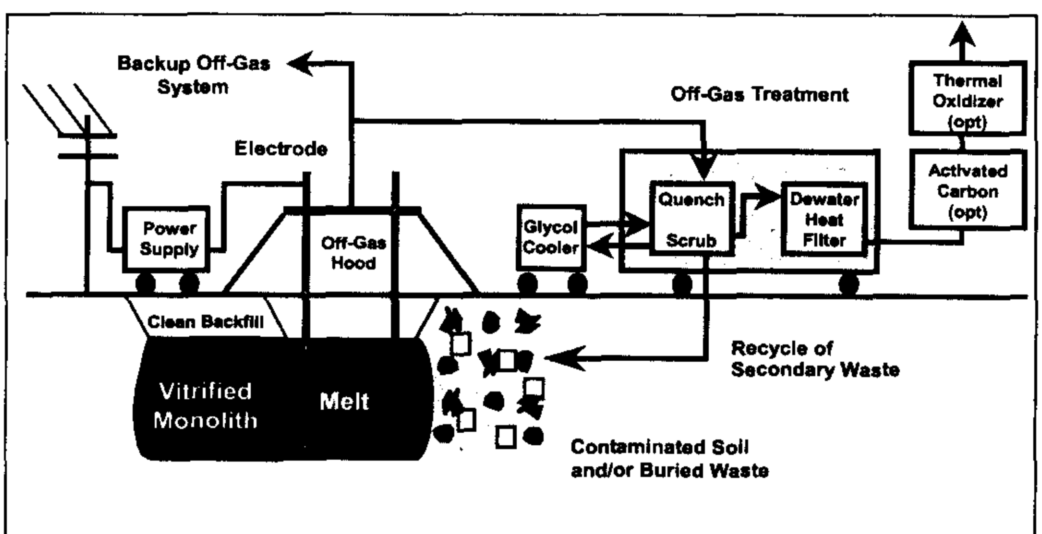


Figure 1. Melting is initiated between pairs of electrodes. Electricity passes through the molten soil and waste, resulting in joule heating. The process melts additional adjacent soil and waste as long as electrical power is applied and until the desired volume has been treated. Off-gases are collected and passed through a treatment system to ensure compliance with air emission standards. The subsidence resulting from volume reduction is backfilled with clean soil to the desired grade.

GeoMelt Description

Contaminants remaining in the molten soil (typically metal oxides) are incorporated into the nonleachable vitrified product. Typical soils undergo a 25% to 50% volume reduction because void space is eliminated.

The residual vitrified product has outstanding physical, weathering, and chemical properties. It is typically 5 to 10 times stronger than unreinforced concrete. It is unaffected by wet/dry and freeze/thaw cycling. It is totally free of organic content and typically far surpasses TCLP leach testing criteria as a measure of heavy metal immobilization efficiency. The vitrified product is analogous to natural obsidian and has an estimated geologic life expectancy (thousands to millions of years).

Equipment System

The GeoMelt equipment system consists of an electrical power transformer, off-gas collection hood, off-gas treatment system, and process control system. All equipment is trailer mounted, except for the off-gas hood, which is transported to the site and then assembled.

The off-gas hood is used to collect emissions escaping from the treatment zone and to support the electrodes used in the melting process. The hood is a dome-shaped structure that completely covers the area to be treated. A low vacuum is maintained in the off-gas hood to collect off-gases, which are then piped to the off-gas treatment system.

The treatment system consists of a quencher, scrubber, demister, heater, particulate filter, activated carbon adsorber, blower, and optional thermal oxidation unit. Off-gas is processed by the quencher to lower its temperature and by the scrubber to remove acid gases and large particulates. It is then dewatered and reheated to prevent wetting of the particulate filters. Last, it is filtered to remove fine particulates and then polished to remove trace organics using either activated carbon adsorption or thermal oxidation.

The entire GeoMelt system is monitored from a process control room where electrode power consumption, off-gas temperature, hood vacuum, and other system parameters are tracked. Figures 2 and 3 show GeoMelt equipment being used at two sites.

Melting Methods

Geosafe employs two basic types of melting methods. One method, conventional top-down melting, can be initiated at the surface or at depth. The second method is a new Geosafe development, planar melting, which is a method of creating tall and thin planar melts in the subsurface. Whereas conventional top-down melting produces a melt typically as wide or wider than the depth processed, the new planar melting technique allows melts to be formed that are much narrower than the melt depth.

For certain situations, planar melting offers several advantages: 1) it can be used for narrow treatment zones (e.g., trenches); 2) greater depths can be reached; and 3) melting can be focused sideways for treating high-gas-generating buried waste and for underground tanks. The development also promises to be suitable for forming rock-like subsurface barrier walls. Figure 4 illustrates the planar and top-down melting methods.

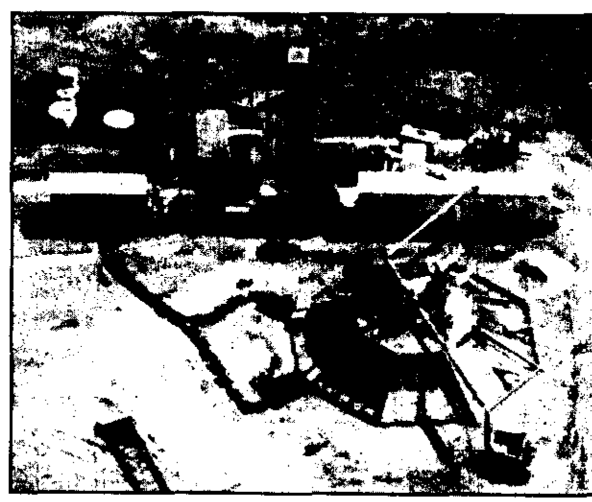


Figure 3. GeoMelt-ISV equipment at the Parsons Chemical Superfund Site in Region V. This 3.75-MW system treated 4,800 tons of pesticide- and metal-contaminated soil at the site. Geosafe's SITE Demonstration for the U.S. Environmental Protection Agency (EPA) was performed here. Electrical power comes from the transformer at the left end of the equipment train to the electrodes on the 60-ft-diameter off-gas collection hood. Off-gases are piped to the treatment trailer at the right of the train.

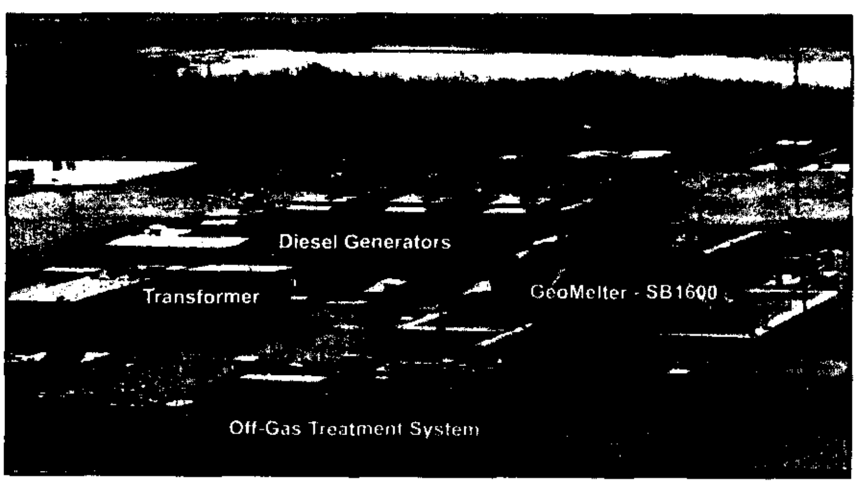


***Figure 2.** The 1.6-MW GeoMelt-Stationary Batch equipment used for treating industrial waste materials in Japan.*

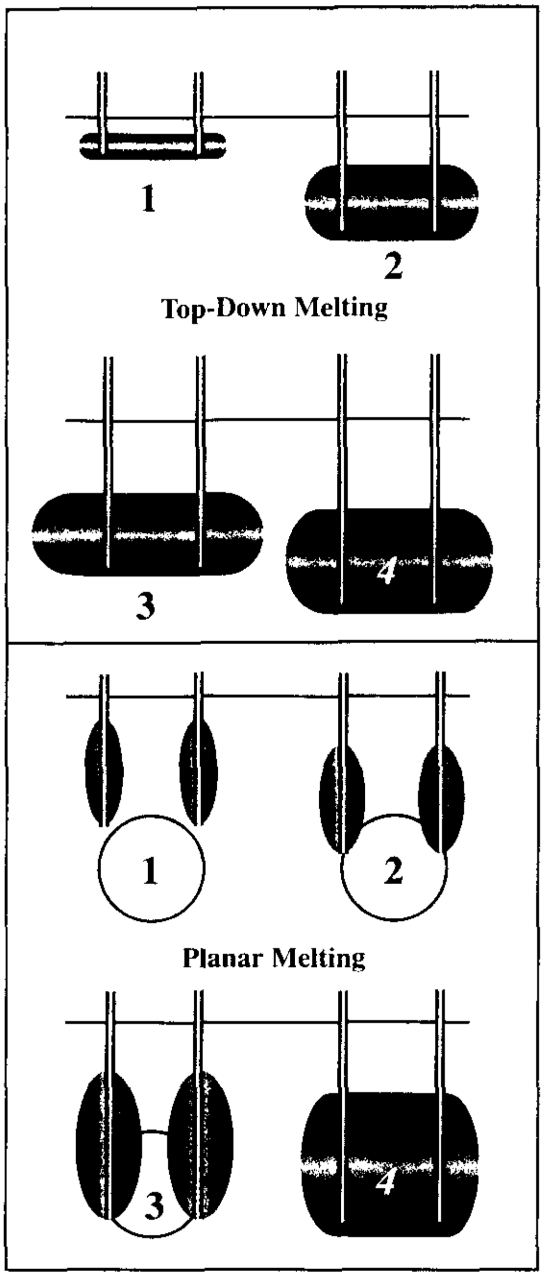


Figure 4. Top-down melting is initiated in a horizontal plane configuration at any desired depth and proceeds downward and outward to treat a desired volume. Planar melting is initiated in a vertical plane configuration and results in predominantly sidewards melt growth, with some downward melting as well. Multiple melts fuse together to make a large contiguous monolith.

Process Information

Operating Temperature: 1600 to 2000°C

Batch Processing Rate: 3 to 7 tons/hr; up to 1500 tons/melt

Online Operating Efficiency: 80% to 90%

Volume Reduction: 25% to 50% for soils; more for wet sludges and combustible wastes

Secondary Waste: Scrubber liquids, spent filters, decon waste, and personal protective equipment; wastes can be recycled into subsequent melts

Utility Requirements: 12.5- or 13.8-kV three-phase electricity; nonpotable water

Power Usage: 600 to 900 kWh/ton of soil processed

Power Demand: Average = 3.2 MW; peak = 4.0 MW

Acceptable Moisture Content: Full saturation

Effective Treatment Depth: Up to 20 ft in a single top-down melt; options exist for deeper processing

Mobilization/Demobilization Time: 2 to 3 weeks each

Minimum Equipment Setup Area: 100 ft x 40 ft next to treatment area

Support Equipment: Fork lift and 35- and 125-ton cranes

Off-Gas Treatment System Capacity: 1800 scfm at 0.5-in. H_2O

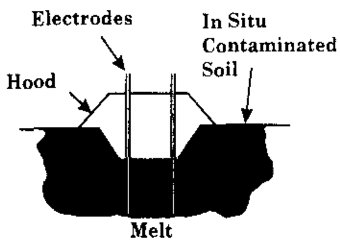
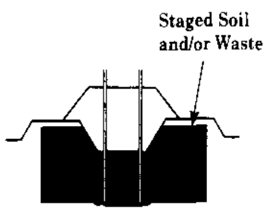
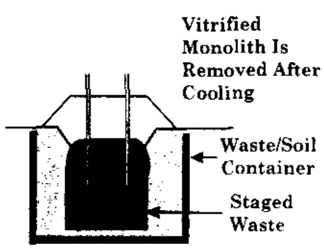
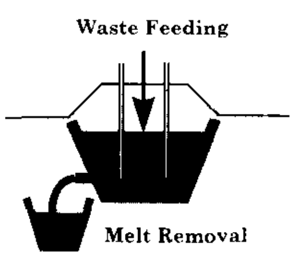
Off-Gas Thermal Oxidizer: Average consumption = 3 MBtu/hr

Off-Gas Emissions:
CO = <0.001 lb/hr
NOx = <1 lb /hr
Particulates = <0.02 lb/hr

Benefits of GeoMelt Vitrification

- in situ capability
- simultaneous processing of organic, inorganic, and radioactive contaminants
- very high organic destruction and removal efficiencies (DRE) and metals retention (immobilization efficiency)
- large volume reduction
- high tolerance for waste and debris
- unequalled vitrified product properties—physical, chemical, weathering, and leaching
- TCLP standards exceeded by the vitrified product
- established public and regulatory acceptance
- demonstrated under EPA's SITE Program; only vitrification technology holding a National TSCA Operating Permit for PCBs
- lowest capital and operating costs for difficult sites

Features and Benefits of GeoMelt™ Vitrification Technologies

GeoMelt Technology	Features	Benefits
GeoMelt-ISV 	Performed on contaminated materials in situ (where they exist) Results in decreasing cost/ton with increasing depth Allows monolith to be left in place or removed	Avoids excavation risks/costs Allows minimum cost for large contaminated land areas Offers process simplicity Provides maximum safety by minimizing occupational, environmental, and public exposure risks
GeoMelt-Staged ISV 	Consolidates and stages materials at optimum depth and preferred location for processing Allows process-enhancing chemicals to be added during staging Enables unacceptable materials to be removed during staging Allows monolith to be left in place or removed	Provides better processing economics for shallow, contaminated soils Enables waste materials and debris to be staged in an acceptable manner for processing Allows processing of materials not otherwise acceptable because of location or concentration Moves materials away from structures or groundwater
GeoMelt-Stationary Batch 	Allows materials to be staged in a treatment cell for processing Enables product composition to be tailored Removes vitrified material after treatment Uses multiple cells for a Treatment, Storage, & Disposal Facility May be used onsite or offsite	Is best suited to waste materials that are stored ex situ Allows alternate final disposal and/or recycle or other productive use of vitrified product
GeoMelt-Continuous 	Allows continuous processing through waste feeding and molten product removal Enables product properties, sizes, and shapes to be tailored May be used onsite or offsite	Is economical for large continuing waste treatment needs Allows higher online efficiency by avoiding startup/shutdown of batch melts Allows alternate final disposal and/or recycle or other productive use of vitrified product

All GeoMelt technologies offer maximum treatment effectiveness, volume reduction, long-term vitrified product life expectancy, tolerance for mixed waste types and debris, and large-scale cost effectiveness.

About Geosafe

Geosafe Corporation was created by Battelle for developing and commercializing advanced vitrification technologies for site remediation and waste treatment worldwide. Geosafe acquired rights to the DOE patented ISV technology, which was developed to treat TRU-contaminated soil in situ. Geosafe has since developed the original joule-heated earth-melting technology into a family of in situ and ex situ vitrification technologies. The large scale of melting operations, the ability to melt without temperature-lowering additives, and the high operating temperature of the GeoMelt technologies make them the most robust of available vitrification technologies.

Geosafe has successfully applied the technologies on a commercial basis at Superfund sites within the U.S. and has a major project underway at the Maralinga Test Range in South Australia to treat mixed-TRU buried waste. Through 1997, Geosafe had processed over 20,000 tons of soil and waste, which is more than the combined tonnage of all other U.S. hazardous and radioactive melters. Geosafe performed a successful demonstration project under the EPA's Superfund Innovative Technology Evaluation (SITE) Program and has been granted a National TSCA Operating Permit by EPA for the nationwide treatment of PCBs at concentrations approaching 18,000 ppm.

Geosafe is a Washington corporation and is headquartered in Richland, Washington. Geosafe's Richland test site is qualified for performance of RCRA, CERCLA, and TSCA treatability tests at melt scales ranging from 100-lb to 1,000-ton melts. Geosafe uses large-scale mobile equipment for remediation of large sites. The company has two sublicensees, Geosafe Australia and ISV Japan, Limited.

Treatment Effectiveness

GeoMelt can effectively treat a wide variety of contaminants that may undergo one or more treatment mechanisms during processing, including 1) thermal destruction in the treatment zone, 2) vaporization and removal from the treatment zone followed by removal and/or thermal destruction by the off-gas treatment system, and 3) permanent immobilization within the residual vitrified product. Disposition varies among individual contaminants, depending on their chemical and physical properties, and GeoMelt processing conditions. Table 1 presents typical disposition information on a total mass basis for sample contaminants classified by volatility. Contact Geosafe for site-specific analyses.

Table 1. Typical Disposition of Contaminants During GeoMelt Vitrification

Contaminant Disposition (Unit Process Efficiencies)	Percent of Total Mass					
	Organics			Inorganics		
	Nonvolatile	Semivolatile	Volatile	Nonvolatile	Semivolatile	Volatile
Contaminant examples	glycol PCBs dioxins furans 2,4,6-TNT HMX RDX	cresols pyridine PCP aldrin chlordane dieldrin DDT	fuel oil MEK toluene TCE xylenes CCl4	barium chromium nickel plutonium radium-226 uranium strontium	cobalt cesium copper lead	arsenic cadmium mercury zinc
Pyrolysis/oxidation in treatment zone (90% to 99.99%)	99.9 to 99.99	99 to 99.9	90 to 99	– –	– –	– –
Off-gas treatment system scrubber/filter (90% to 99.99%)	0.009 to 0.099	0.09 to 0.99	0.09 to 0.9	0.0009 to 0.99	0.99 to 9.9	9.9 to 99
Carbon adsorption (optional) (90% to 99%)	– –	– –	– –	0.000099 to 0.0099	0.0099 to 0.09	0.09 to 0.999
Thermal oxidation (optional) (99% to 99.9%)	0.0009 to 0.000999	0.009 to 0.0099	0.0999 to 9.9	– –	– –	– –
Chemical incorporation into nonleachable glass (0 to 99.999%)	– –	– –	– –	99 to 99.999	90 to 99	0 to 90
Total percent mass removed, destroyed, or immobilized by GeoMelt	**99.9999 to 99.999999**	**99.999 to 99.9999**	**99.99 to 99.9999**	**99.9999 to 99.999999**	**99.99 to 99.9999**	**99.99 to 99.999**

Comparison to Alternative Technologies

Table 2 compares GeoMelt with five other onsite soil treatment technologies in regard to several important application criteria. The comparison indicates the qualities of GeoMelt that may make it the most cost-effective solution for various sites, particularly those with stringent cleanup standards, mixed organic and heavy metal (including radioactive) contaminants, significant quantities of debris, and where in situ treatment is preferred. Geosafe obtained information on the alternative technologies from EPA SITE Program literature and other publicly available documents.

Table 2. Comparison of GeoMelt with Alternative Soil Treatment Technologies

Comparison Criteria	GeoMelt Vitrification	Other Vitrification	Onsite Incineration	Hydrogen Reduction	In Situ Solidification	Thermal Desorption
Effectiveness						
Organic: Volatile	●	●	●	●	□	●
Semivolatile	●	●	●	●	□	●
Pesticides	●	●	●	●	○	■
PCBs	●	●	●	●	○	■
Dioxins/Furans	●	●	○	●	○	□
Inorganic: Volatile Metals	■	○	■	□	■	□
Nonvolatile Metals	●	■	□	□	■	□
Asbestos	●	■	□	□	●	□
Radioactive	●	■	□	□	○	□
Corrosives	●	■	□	□	□	□
Screening Comments						
Commercially demonstrated	●	○	●	●	■	●
Able to treat broad range of media types	●	○	●	○	○	■
Effective for both organics and metals	●	●	□	□	○	□
Able to tolerate significant debris	●	□	■	□	□	○
Able to meet most stringent cleanup standards	●	■	●	■	○	■
Regulatory and public acceptance	●	○	○	■	○	●
Typical Cost ($/ton)	370 to 420	500 to 1000	350 to 400	500 to 800	150 to 300	300 to 350

Legend: ● Excellent/Demonstrated ■ Good ○ Fair/Potential □ Poor

Limitations

When considering applying the GeoMelt vitrification technologies, the following limitations may apply:

- Treatment depths over 20 ft may require special provisions.
- Total organic content should be <30 wt%.
- The media must be acceptable for joule-heated melting.
- Water recharge rates $>1\times10^{-4}$ cm/s may warrant the use of a dewatering system.
- Sealed containers of liquids or gases require preconditioning.
- Very large voids must be filled or collapsed.

For More Information

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- Matthew J. Haass, Senior Business Development Engineer (mjhaass@owt.com)

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Vitrification of TRU-Contaminated Buried Waste: Results From Radioactive Demonstrations at Taranaki

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ABSTRACT

The Maralinga Nuclear Test Range, located in South Australia, is a former nuclear weapons test site that was used by the British in the 1950's and early 1960's. Both nuclear detonations (major trials) as well as chemical detonations of warheads (minor trials) resulted in extensive contamination of the site. At Taranaki, Maralinga's most heavily contaminated area, a series of minor trials involving the explosive dispersal of plutonium and uranium resulting in extensive contamination of surface soil and generated massive quantities of contaminated debris. The heavily contaminated debris from the trials was subsequently buried in a series of shallow pits at Taranaki.

The Commonwealth Government's Department of Primary Industries and Energy (DPIE) is undertaking a program to rehabilitate the most heavily contaminated areas at the site. A major part of the program is directed to reduce the risk presented by the contaminated debris buried in the pits at Taranaki. DPIE has identified the in situ vitrification (ISV) technology as the preferred technology for treatment of the Taranaki Pits. As part of this program, Geosafe recently completed two multi-ton radioactive demonstrations of the ISV technology at the site. The demonstrations involved preparing test pits which included 37 wt% steel, and other debris including lead, baryte shielding bricks and organic-based materials. Actual plutonium-contaminated debris originating from the original weapons tests was used in one demonstration and each demonstration involved the vitrification of one kg of uranium oxide.

Results indicate that all demonstration objectives were met and that >99.999% of the radioactive materials were retained in the melt. No detectable activity was found inside the off-gas containment hood or on the insides of the off-gas piping.

Preliminary radiochemistry analyses and X-Ray Fluorescence analyses indicate that the radioactive materials are uniformly distributed throughout the vitreous product. Leach tests of the vitrified product using the Product Consistency Test procedure at 7 and 28 day leaching intervals indicate that the normalized leach rates are extremely low (<0.1 g/m^2) for all oxide species.

This international application of the ISV technology on TRU-contaminated buried waste represents a major milestone in the deployment of the DOE-developed ISV technology. This paper will present a overview of the Maralinga Rehabilitation Program and discuss the two radioactive ISV demonstrations conducted at the site. In addition, plans for the remaining phases of work will be discussed.

THE MARALINGA SITE

Atomic weapons were developed and tested in Australia at Maralinga by the British Government from 1955 to 1963. Seven atomic explosions during 1956 and 1957 resulted in fission product fallout. Several hundred ancillary experiments (minor trials) were conducted, some of which involved explosive dispersion or burning of metallic plutonium, uranium and beryllium in the open environment. Weapons development ceased in 1963, following the Partial Test Ban Treaty. Several attempts at clean-up of the Maralinga site were made by Britain. The last was Operation Brumby in 1967, during which contaminated areas of soil were plowed to mix and dilute the level of surface contamination, and debris pits containing plutonium were capped with concrete. The site then reverted to Australian control. Details of the operations at Maralinga were summarized by Symonds (1985). Interest in rehabilitation of the site was revived in 1984 by the Australian Royal

Commission into British Nuclear Tests in Australia. The recommendations of the Commissioner (Royal Commission, 1985) included a further clean-up to permit unrestricted access of Aboriginal people to the former test sites.

Maralinga is situated in the State of South Australia, between the Nullarbor Plain and the Great Victoria Desert, 40 km north of Watson siding on the Trans Australia Indian Pacific Railway (Figure 1). The area of the site is 3,210 km^2. Maralinga has a semi-arid environment with an average of 200-mm annual rainfall. Average temperatures range from 33°C in January to 18°C in July, with summer temperatures frequently in excess of 40°C. The weapons development tests were conducted on Tietkens Plain, an outcrop of limestone and dolomite, partly covered by sand and bordered by vegetated sand hills.

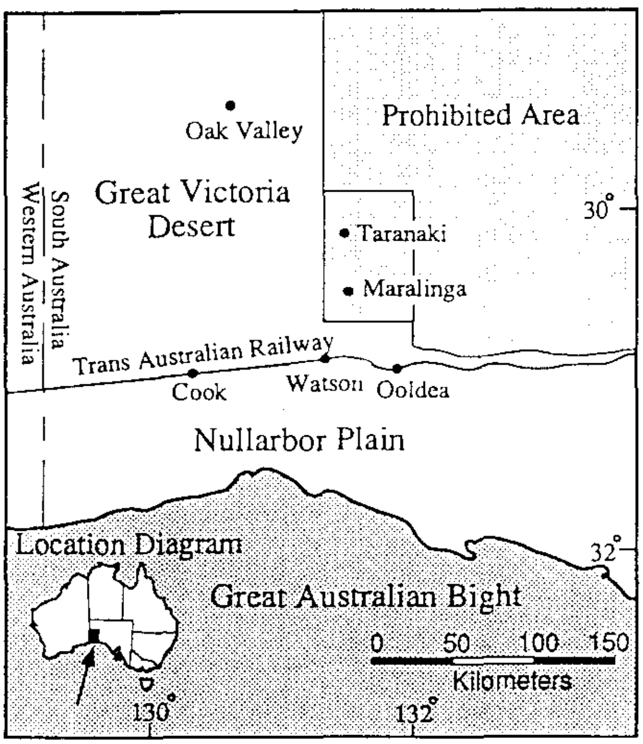

Figure 1. Maralinga Test Range is located in the State of South Australia on the edge of the Great Victoria Desert.

THE MARALINGA REHABILITATION PROGRAM

The Technical Assessment Group (TAG) was established by the Australian Government in February, 1986, to conduct scientific and engineering field studies, laboratory research and pilot operations necessary to define a range of realistic and cost-effective rehabilitation options. The scientific studies commenced with an aerial radiological survey of the former test sites, and included field and laboratory work to assess concentrations of residual radioactive isotopes in native foodstuffs, soils and inhalable dusts at Maralinga.

Dosimetric modeling of potential radiological dose through the pathways of ingestion, inhalation and wound contamination during the activities of a semi-traditional Aboriginal lifestyle led the TAG to conclude that the current radiological hazard at Maralinga resulted from the dispersal by chemical explosion of about twenty-two kilograms of metallic plutonium in twelve Vixen "B" one-shot minor trials at the Taranaki test site between August 1960 and April 1963. In these trials, each nuclear device was detonated by chemical explosive on an exposed "featherbed" structure. The "featherbed" consisted of massive steel plates and walls of lead and baryte bricks mounted on rolled steel joists. The detonation of the devices produced a measurable, but negligible, nuclear energy yield in most shots. Plutonium was dispersed as fine oxide dusts, as sub-millimeter particles, and as surface contamination on larger fragments of debris from the destruction of the "featherbed".

REMEDIATION OPTIONS

Engineering studies by the TAG defined a series of engineering work packages using established technologies for treatment of contaminated land and debris pits.

The report by TAG (1990) to the Australian Government contained nine rehabilitation options and about 29 sub-options. The options ranged from low cost/resource/risk (e.g., fencing and exclusion of contaminated areas) to high cost/resource/risk (e.g., collection and disposal of contaminated soil and the contents of debris pits). The scope of rehabilitation covered access by semi-traditional Aboriginal Communities, primarily the residents of Oak Valley, ranging from casual access to fully unrestricted habitation.

Data from safety trials conducted at the Nevada Test Site (Eberline Instrument Corporation, 1966) indicated that about twenty percent of the plutonium detonated at Taranaki (i.e., about four kilograms of plutonium) might have been deposited in the near field of the detonations. Twenty one numbered shallow debris pits in a fenced area at Taranaki have been reported to contain about 820 tones of debris and 1150 tones of soil contaminated with plutonium from the Vixen "B" trials. Pending further evidence, the pits have been assumed to contain between four and twenty kilograms of plutonium. This paper is focused on the stabilization of the contents of these debris pits.

STABILIZATION OF DEBRIS PITS

TAG (1990) considered three options for stabilization of the plutonium debris pits: exhumation and reburial of the pit contents, stabilization by concrete grouting, and stabilization by in situ vitrification.

Exhumation processes considered involved excavation of debris and contaminated soil into rectangular steel boxes, for disposal either in deep boreholes, or in a lined and capped sub-trench below the trench for disposal of collected contaminated surface soil. Exhumation would require intensive radiological protection of personnel against inhalation of plutonium dusts.

Grouting procedures assessed included a combination of in-pit grouting, grouting of adjacent rock and soil, with concrete capping, cut-off walls and tumuli over the grouted pits. A major problem in the grouting option was the uncertain degree of void filling and consequent doubtful degree of improvement in long-term safety.

In situ vitrification (ISV) is a U. S. Department of Energy developed process being commercially applied by Geosafe Corporation[a]. The process involves electric melting of contaminated soil and debris and/or other earthen materials for purposes of permanently destroying, removing, and/or immobilizing hazardous and radioactive contaminants.

Melt temperatures typically reach 1400-2000°C by passage of (typically) 3 to 4 MW of electrical power with a square array of four electrodes. Off-gases are collected for treatment in a steel containment hood that spans the area being processed. When electrical power is shut off, the molten mass solidifies into a vitrified monolith with unequaled physical, chemical and weathering properties compared to alternative solidification/stabilization technologies. For the Maralinga application, the ISV process would melt the soil and debris contained in the pits. The plutonium oxide would be incorporated into a stable leach resistant vitreous/ceramic block, with steel debris melting to form an encapsulated steel ingot.

The ISV process appeared to have advantages of improved occupational, public, and environmental safety together with greatly improved containment of the radioactive materials in the vitrified product that would be much more durable compared with alternative stabilization methods. This conclusion was subject to the proviso that the presence of limestone and the contents of the pits did not adversely affect process efficiency and that the logistics for operation of the process at Maralinga could be resolved. The Australian Government decided to proceed on the basis of an option which involved collection and trench burial of the more highly contaminated surface soil, and determination of the applicability of ISV for stabilization of the contents of the debris pits.

DESCRIPTION OF THE MARALINGA ISV PROJECT

The ISV project was structured as a four phase project. Phase 1, conducted in 1993 and 1994, involved an initial study to determine if the ISV process was suitable for the application. The study included a site visit to evaluate the site conditions and involved engineering-scale ISV tests and crucible melt studies using debris and uncontaminated soils from the site. Phase 1 results indicated that the ISV process could be applied to the soil and debris combinations at the site.

Phase 2, conducted in 1995, involved a series of ten on-site engineering-scale tests and three intermediate-scale demonstrations to obtain site-specific process data.

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a. Geosafe Corporation has successfully applied the ISV technology to remediate three Superfund Sites involving all contaminant classes (VOCs, SVOCs, and metals). All three Sites required the treatment of substantial amounts of debris including wood, plastic, rubber, cardboard, protective clothing, HEPA filters, drums, concrete, asphalt, tires, scrap metal, and demolition debris. The process has been successfully used to treat mixtures of contaminants including high levels of dioxin, pesticides, and PCBs and has been previously demonstrated at full-scale for use on radioactive contaminants. Geosafe has received a National TSCA permit for the ISV process to treat PCBs at concentrations up to 17,860 ppm.

Two of the intermediate-scale demonstrations used radioactive materials, including blast debris from the original weapons tests. These two radioactive demonstrations are the subject of this paper. The principal goal for the intermediate-scale radioactive ISV demonstrations was to collect sufficient data to determine if the ISV process could be expected to effectively treat the contaminated soil and debris in the Taranaki pits and to obtain data to confirm the behavior of plutonium in the process. Data from the tests and demonstrations were also gathered to support the design of a full-scale ISV process machine that will be tailored for the site-specific conditions and to develop a remedial design plan which will define the approach and logistics associated with the full-scale treatment at the site. Specific objectives were established for each demonstration so that the performance of the ISV process and the resulting vitrified product could be evaluated against the performance criteria established for the project.

Science and engineering advisors representing the Commonwealth helped determine ISV process performance criteria for the application and were present to observe activities during key stages of the demonstration project.

The demonstrations were configured in a manner that was thought to best represent the configuration of the actual pits as well as the actual types and amounts of debris buried in the pits. Standard scaling relationships established for the ISV process were used in conjunction with historical data that describes the pits and the pit contents to develop scale mock-ups of a typical Taranaki pit.

An intermediate-scale (85 kW) system capable of producing melts up to 4,500 kg (5 tons) was constructed for the project. Figure 2 is a photograph of the ISV equipment as positioned for the second radioactive demonstration involving plutonium. This size of system provides cost effective data that can be directly scaled to the full-size application. The off-gas treatment system was designed specifically to handle the higher off-gas generation rates and higher off-gas temperatures expected to result from processing buried wastes. In addition to the steel and radioactive materials, the pits contained significant amounts of gas generating materials such as sulfates, carbonates, and organics.

RADIOACTIVE ISV DEMONSTRATIONS

The two radioactive demonstrations involved the treatment of soil, 37 wt% steel debris, and other debris including bitumen-stabilized soil, lead, plastic, electrical cable and baryte bricks. The baryte bricks were originally used as radiation shielding material and are composed of barium sulfate. Figure 3 is a photograph of one of the pits being filled with debris and soil. One kilogram of uranium oxide was buried in each pit to serve as a surrogate for plutonium. For each demonstration melt, the uranium oxide was contained in a plastic bag and located in the center of each pit to serve as a highly localized area of contamination. The second radioactive demonstration included a steel plate, originating from the weapons tests, that was contaminated with approximately 0.5 grams of plutonium oxide (predominantly ^{239}Pu with about 3% being ^{241}Pu). About 90% of the ^{241}Pu originally on the plate had decayed to ^{241}Am.

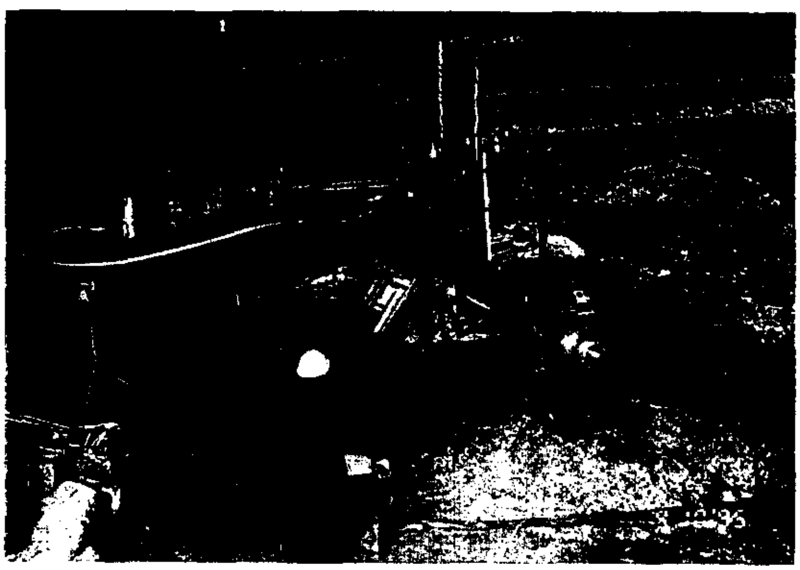

Figure 2. A Geosafe worker adjusts the insertion depth of the electrodes during the Plutonium Demonstration.

Each demonstration melt was conducted at opposite ends of a trench. In order to best represent the geochemistry of the limestone-based soil surrounding the Taranaki pits, the tests were conducted in the Taranaki area adjacent to two of the larger waste burial pits.

Figure 3. Debris in the pits included steel, lead, baryte bricks, electrical cable, plastic and bitumen-stabilized soil.

The two demonstrations were conducted in September and October of 1995. The first demonstration occurred over an 84 hour time period while the second demonstration occurred over a 96 hour time period. During the operations, process-related data, such as electrical power and off-gas related data, was collected to support the design process for a full-scale ISV machine that will be tailored specifically for the site.

Following the two demonstrations, the resulting vitrified monoliths were excavated for examination, weighing, and sampling. The mass of the first demonstration monolith was determined to be 3,766 kg (4.15 tons). The mass of the second demonstration monolith was determined to be 4,292 kg (4.73 tons). Figure 4 is a photograph of the second demonstration monolith being weighed.

RESULTS AND OBSERVATIONS

Both demonstrations were completed successfully. Physical characterization of the vitrified blocks and radiochemical analyses have been completed. Additional analyses, including a variety of leach tests, are currently underway. Based on the available data, the following observations and conclusions can be made concerning the demonstrations:

- The ISV process was demonstrated to be capable of melting the soil and debris combinations in the pit including the 37 wt% steel. In addition, the non-steel debris in the pit (baryte bricks, cable, lead, bitumen stabilized soil, and plastic) did not pose any processing difficulties.

- The voids and gas generating materials in the pits (carbonates, sulfates, and organics) did not pose any processing difficulties with respect to off-gas containment. The off-gas treatment system's high off-gas flow rate was fully sufficient to accommodate the high steady state off-gas generation rates and transient off-gas surges that resulted from processing the gas generating materials and voids.

Figure 4. The vitrified block resulting from the Plutonium Demonstration. The mass of the block was determined to be 4.73 tons.

- The volume reduction for the soil and debris treated was 47% for the first demonstration melt and 55% for the second demonstration melt.

- Based on isokinetic off-gas sampling, the amount of uranium oxide retained in the first demonstration melt was 99.99987% and the amount retained in the second demonstration melt was 99.99968%. Using the same isokinetic off-gas sampling methods, the amount of plutonium retained in the second demonstration melt was determined to be 99.99997%.

- Following the demonstrations, health physics-related surveys of the equipment established that the insides of the off-gas containment hood, off-gas piping, and primary HEPA filters were free of detectable contamination above background levels (<0.25 Bq alpha and beta combined per 100 cm^2 surface area). Consequently, decontamination of the equipment was not required.

- The plutonium, uranium, and americium in the vitreous phase are not smearable. Significant intrusive sampling activities resulted in the creation and handling of many small fragments of vitrified product but did not result in the transfer of any detectable contamination to tools or personnel.

- Based on X-Ray Fluorescence analyses and alpha spectrometry analyses of samples, the plutonium and uranium oxides were found to be uniformly distributed throughout the vitreous phase. Table I provides a summary of the data for several samples from the Plutonium Demonstration.

- The metal phase at the base of each melt was determined to be free of plutonium and uranium.

- Leach tests of six samples of vitrified product, conducted in triplicate, using the Product Consistency Test Procedure at intervals of 7 and 28 days indicate that the normalized leach rates for all oxides in the vitrified product are less than 0.1 g/m^2. The leach tests included standard PCT tests as well as modified leach tests using leachants with pH values of 5, 7 and 10

Oxide/Species	Sample Number			
(wt%)	Pu-E-3	Pu-X-3	Pu-OB-2	Pu-CC-2
Al_2O_3	7.31	7.35	7.40	7.08
SiO_2	59.7	59.8	59.8	59.5
CaO	25.3	25.3	24.9	26.1
Na_2O	0.499	0.496	0.518	0.481
K_2O	0.831	0.832	0.846	0.803
Fe_2O_3	2.91	2.91	2.98	2.80
MgO	1.12	1.12	1.13	1.07
PbO	0.108	0.111	0.112	0.108
U_3O_8	0.041	0.040	0.041	0.040
Pu (Bq/g)	317	317	327	300

Table 1. XRF and alpha spectroscopy results for samples of vitrified product from the Plutonium Demonstration indicate that the melt was well mixed.

CONCLUSIONS

The data and observations resulting from the radioactive ISV demonstrations conducted at the Maralinga site support the following primary conclusions concerning the likely performance of the ISV process on the Taranaki pits:

- The ISV process, at full-scale, can be expected to effectively treat the soil and debris combinations in the Taranaki pits.

- The data indicates that an ISV process machine designed specifically for this application will be capable of handling the higher off-gas temperatures and transient off-gas flows associated with the treatment of the buried wastes.

- The vast majority (>99.9999%) of the plutonium will be retained in the melt and will be uniformly distributed throughout the vitreous phase.

- The vitrified product will be a uniform, dense, hard product of high strength with exceptional leach resistance.

- Plutonium will not be distributed to any significant extent to other phases in the melt.

- The ISV process can be safely applied to the materials present at the Taranaki site.

PLANS FOR SUBSEQUENT PHASES OF WORK

The two radioactive demonstrations provided an opportunity to obtain site-specific process performance data to evaluate the ISV process for this application. The data will be used to develop a remedial design plan for the full-scale application to determine the most efficient, safe and economical approach to treat the Taranaki pits with the ISV technology. In addition, the data is being used to design a full-scale ISV process machine that is being tailored to accommodate the specific characteristics and treatment requirements of the site. Phase 3 will involve the construction of the full-scale ISV machine. Phase 3 is expected to commence in 1996. Phase 4 involves the actual treatment of the Taranaki pits. Phase 4 is expected to commence in 1997.

REFERENCES

1. SYMONDS, J. L., "A History of British Atomic Tests in Australia," Department of Resources and Energy, Australian Government Publishing Service, Canberra (1985).

2. Royal Commission, "The Report of the Royal Commission into British Nuclear Tests in Australia, Volumes 1 & 2," Australian Government Publishing Service, Canberra (1985).

3. "Rehabilitation of Former Nuclear Test Sites in Australia. Report by the Technical Assessment Group," Department of Primary Industries and Energy, Commonwealth of Australia, Australian Government Publishing Service, Canberra (1990).

4. "Operation Roller Coaster. Project Officer's Report - Project 2.1," Eberline Instrument Corporation, POR-2501, 31 January 1966.

GeoMelt™ Technology Update

Published by Geosafe Corporation February 1998

Advanced Vitrification Solutions for Site Remediation and Waste Treatment

Special DOE Focus Issue

This issue focuses on potential applications of the **GeoMelt** vitrification technologies to site remediation and waste treatment needs throughout the U.S. Department of Energy's (DOE's) Weapons Complex. Many potential applications within DOE's Environmental Management Program can be competitively addressed by **GeoMelt** vitrification.

GeoMelt™ Technology Update is published periodically by Geosafe Corporation to provide current information regarding the development, commercialization, and technical status of the **GeoMelt** technologies. Comments on past issues and suggestions for future articles are welcomed.

Inside This Issue

Planar GeoMelting...

New Invention Opens New Applications

Geosafe has invented and developed **planar melting**, an innovative new way of melting. Planar melting adds significantly to the capabilities of Geosafe's GeoMelt vitrification technologies.

GeoMelt is a family of vitrification technologies based on the original in situ vitrification (ISV) technology developed by DOE and Battelle Memorial Institute in the 1980s. The GeoMelt family includes four treatments: 1) **GeoMelt-ISV** for in situ applications, 2) **GeoMelt-Staged ISV** for treating materials that have been staged for processing, 3) **GeoMelt-Stationary Batch** for repetitive melt cycling at a single location, and 4) **GeoMelt-Continuous Vitrification** for material feeding and melt withdrawal at a stationary facility.

Geosafe also employs two basic types of melt configurations. One configuration, conventional **top-down melting**, can be initiated at the surface or at depth. The second configuration is the new Geosafe development, **planar melting**, which is a method of creating tall and thin planar melts in the subsurface. Whereas conventional top-down melting produces a melt typically as wide or wider than the depth processed, the new planar melting technique enables formation of melts much narrower than the melt depth.

Planar melting has several advantages over top-down melting in certain cases: 1) it can be used for narrow treatment zones (e.g., trenches); 2) greater depths can be reached; and 3) melting can be focused sideways for buried waste and underground tanks. The development also promises to be suitable for forming rock-like subsurface barrier walls.

Planar melting allows safe and quick treatment of wastes that generate high gas volumes upon treatment. Top-down melting is limited with such wastes because of the need to avoid excessive gas movement through the melt. In planar melting, such gases may be expected to move to the surface through the adjacent soil or waste rather than the melt.

Figure 1 illustrates how planar melting may be applied to in situ remediation of an underground tank. Before planar melting is started, the tank is filled with a lower melting point soil to focus the melting in the tank. Two planar melts are started in the overburden and allowed to grow into opposite sides of the tank. Liquids and other gas-generating materials present in the tank are allowed to vent to the surface through the media present between the converging planar melts. The gases are then directed to the off-gas treatment system. Figure 2 shows a large tank being prepared for testing.

Geosafe is currently under contract to DOE to demonstrate this new capability, which has been developed through large-scale. Results will be available this summer.

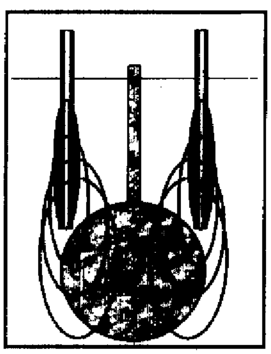

Figure 1. Illustration of how planar melting is applied to an underground tank.

Figure 2. A tank being prepared for large-scale testing.

Preconditioning Methods for Buried Waste

Waste preconditioning methods have been identified for making buried waste sites acceptable for safe and economic GeoMelt processing. Buried wastes are common throughout the DOE Complex, and they represent some of the most difficult remediation challenges. It is highly desirable to be able to treat such wastes in situ.

Buried waste in its natural state is typically characterized by 1) large voids and generally low density, 2) sealed containers of wet materials (e.g., sludges and liquids), 3) high combustible materials loadings, and 4) the presence of widely varying wastes and debris, including large steel objects. These conditions can be of concern to GeoMelt processing primarily because of variable and excessive off-gas generation rates. These concerns can be eliminated or made acceptable by using the following preconditioning methods. Individual buried waste sites may require different combinations of preconditioning methods.

- **Dynamic disruption**...for reducing void volume, puncturing sealed containers, and probing for large metal objects. This method uses a vibratory hammer to power a structural penetrator into and through the waste. The high mechanical energy field around the penetrator allows soil to flow into voids and disturbs container integrity. The method can punch holes through buried drums and other containers. See the Maralinga article on p. 3 for an illustration on using dynamic disruption at that site.
- **Dynamic compaction**...for void volume reduction and crushing of sealed containers. This method involves dropping 10- to 30-ton weights from a special crane to compact the underlying waste. This method has been successfully used at DOE's Savannah River, Oak Ridge, and Los Alamos sites. It is not unusual to obtain volume reductions of 30% to 50% from such treatment. Vitrification then produces additional volume reduction, depending on the nature of the materials being treated.
- **Thermal predrying with soil vapor extraction (SVE)**...to remove water and other liquids. This method involves placing heating elements into the waste to volatilize water and organic liquids and using SVE to augment removal of gases and vapors from the heated volume. The extracted vapors are then treated by the off-gas system.
- **Application of overburden**...to moderate variable gas generation rates and to enable greater melting efficiencies. Overburden insulates the top of a melt, greatly diminishing heat losses to the off-gas hood.
- **Solids injection**...to fill large voids that cannot otherwise be reduced by dynamic disruption or compaction. This method involves high-pressure injection of grout or other solid materials into large voids. This method has been demonstrated within the DOE Complex.

Stationary Batch Processing for Treating Stored Waste

Geosafe has developed methods for batch treatment of soil and waste materials at a stationary location. This method involves treating contaminated media within the confines of a treatment cell. The cell, typically concrete, is filled with contaminated media, with a buffer of clean soil between the contaminated volume and the concrete. The cell is covered with an off-gas collection hood, and either conventional top-down or planar melting is performed. Figure 3 illustrates a GeoMelt-Stationary Batch treatment cell that can be located above, below, or partially below grade. Figure 4 shows a 1.6-MW stationary batch system that is operating in Japan for treating diverse industrial wastes.

After the vitrified product is cooled and removed, it can be readily broken into pieces of appropriate size for disposal, containerization, and shipping. The treatment cell is then restored to accept additional waste. The size and number of treatment cells depend on the production rate desired. Stationary batch treatment of waste offers two key advantages relative to other technologies. It can process 1) heterogeneous waste and debris materials without pretreatment, and 2) waste without temperature-lowering additives. These factors greatly reduce the cost and increase the safety of treating waste materials. Alternative ex situ vitrification technologies typically cannot accept heterogeneous waste without size reduction, shredding, and/or grinding; and they significantly increase the mass of material to be melted because temperature-lowering chemicals must be added.

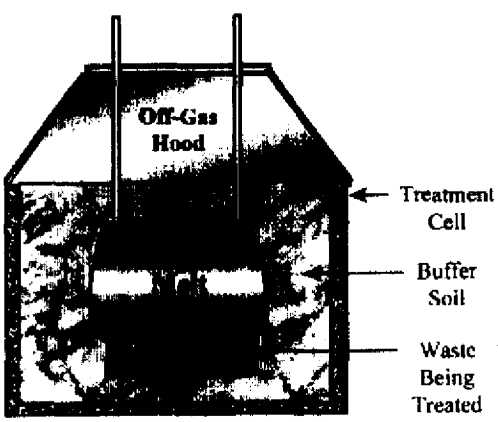

Figure 3. Cross-section of a stationary batch treatment cell.

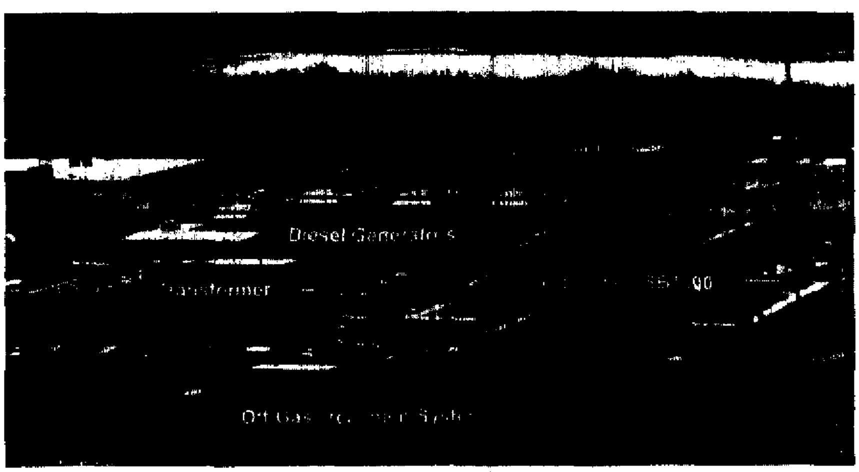

Figure 4. The 1.6-MW stationary batch system operating in Japan.

Maralinga Project on Track

Geosafe Australia is applying GeoMelt-ISV for treatment of 21 burial pits containing mixed transuranic buried waste (U, Pu, Ba, Be, and Pb) at the Maralinga Test Range in South Australia. Phases 1 and 2 of the project, which involved testing, are complete; and Phase 3, which involved equipment design and construction, is nearing completion.

This equipment system, designed specifically for the Maralinga project, can melt up to 150 ton/day. At 4.8-MW capacity, this is the largest GeoMelt vitrification system to date (see Figure 5). The high power level was selected in order to be able to treat large waste items such as structural steel beams and plate, lead and barytes bricks, drums, cabling, and other waste and debris. The system is diesel powered because of the site's remote location. Figure 6 shows the off-gas hood assembled with electrodes.

Phase 4 of the project is now underway. This phase involves the preparation and subsequent treatment of the pits. Preparation involves removing concrete caps that exist above the pits (see Figure 7) and wrapping them to avoid contamination spread. After the cap is removed, the pit is backfilled with soil and then probed by a hydraulically vibrated structural penetrator to promote filling of voids and to determine actual pit boundaries (see Figure 8).

Once the pits are prepared in this way, Geosafe Australia will treat the pits using GeoMelt-ISV. Melting work is presently scheduled to com-mence in April 1998.

Persons interested in visiting the Maralinga site may contact Geosafe to explore arrangements. Because the trip to Maralinga is costly and time consuming, Geosafe plans to present a Maralinga workshop in the United States during 1998. The workshop will feature the experience and results of the pit remediation project. If you are interested in attending the workshop, contact Geosafe to place your name on a notification list.

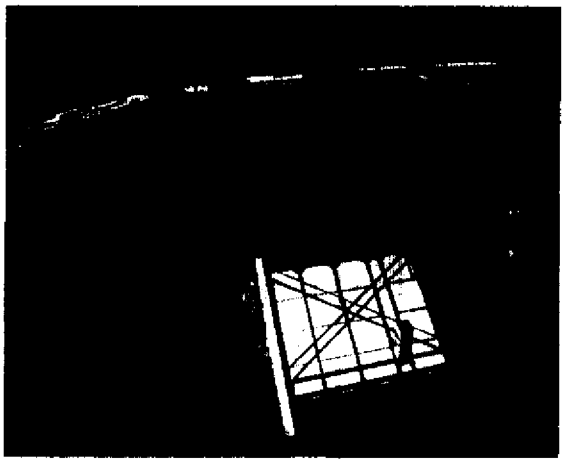

Figure 5. The 4.8-MW GeoMelt-ISV system.

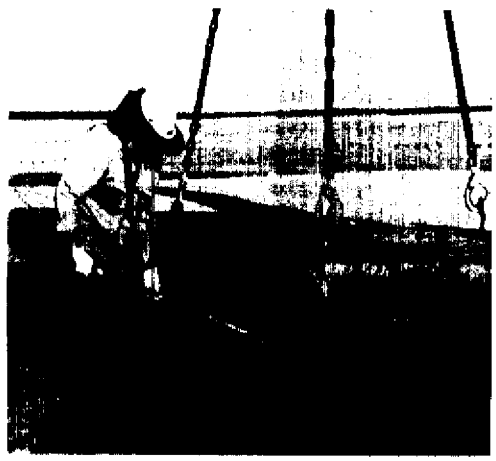

Figure 7. Concrete cap being lifted off a pit.

Figure 6. Off-gas hood assembled with electrodes.

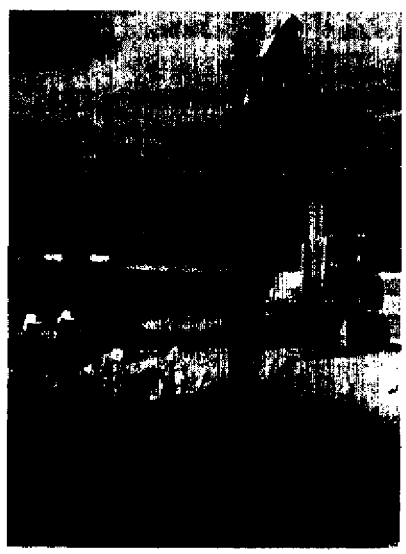

Figure 8. Dynamic probing of a pit.

GeoMelt: Better, Faster, Cheaper

GeoMelt vitrification technologies offer the following significant benefits for treating very difficult sites and waste materials.

- **in situ and ex situ treatment options** - The four GeoMelt vitrification methods can be adapted to nearly all site and waste conditions.
- **simultaneous treatment of hazardous and radioactive waste** - All contaminant types are dealt with simultaneously, thereby minimizing the need for extensive treatment trains.
- **no need for temperature-lowering additives** - The process does not require additives to lower melt temperature. This greatly reduces the mass of material that must be melted and the associated costs.
- **no need for size reduction pretreatment** - The robustness (scale and temperature) of the process allows nearly all waste and debris materials to be processed without any pretreatment such as size reduction, screening, grinding, and the like, which typically are required of processes that use feeding devices. This greatly reduces cost.
- **high tolerance for heterogeneity** - The robustness and batch nature of the process enable treatment of highly heterogeneous waste. The process accommodates wide variations in earthen media and waste types.
- **lesser characterization requirements** - The robustness and tolerance for heterogeneity enable less rigorous and less costly site and waste characterization.
- **maximum treatment effectiveness** - The process results in maximum reduction in mobility, toxicity, and volume.
- **superior vitrified product** - The process produces a vitrified product with unequaled physical, chemical, and weathering properties. The product is superior relative to TCLP and PCT leach testing and has a geologic life expectancy.
- **excellent regulatory and public acceptance** - The process has been well accepted by regulators and the public in states where Geosafe has performed projects, including Michigan, Utah, and Washington.
- **demonstrated proven technology** - The process has been successfully demonstrated through the U.S. Environmental Protection Agency's (EPA's) SITE Program, and Geosafe has obtained a National TSCA Operating Permit from EPA for treating PCBs anywhere in the United States.
- **simplicity and reliability** - The process uses fewer equipment subsystems than other vitrification processes (e.g., no feeding and withdrawal equipment). Equipment reliability has been demonstrated; more than 20,000 tons of material have been treated to date.
- **lower operating and capital costs** - The robustness, treatment effectiveness, and volume reduction of GeoMelt processing enable significantly lower precharacterization, operating, capital, long-term maintenance, and overall life-cycle costs.
- **onsite and in situ safety** - Inherent safety results from onsite and in situ treatment. No injuries have been associated with GeoMelt processing since the technology's inception in 1980.

How To Evaluate GeoMelt

Geosafe offers a free **Applicability Analysis** to potential clients. The analysis involves a review of site information relative to Geosafe's existing experience database. Geosafe's applicability analysis includes 1) an assessment of whether the contaminated media/waste can be treated, 2) a recommendation regarding the type of GeoMelt technology that should be used, 3) expected contaminant disposition, 4) a feasibility study-quality cost estimate, and 5) a recommendation regarding the need for treatability testing.

Geosafe performs **Treatability Testing**, if necessary, at its test site in Richland, Washington, or at the client's site. Treatability testing generates 1) production-related information that is important to remedial design and cost estimating, 2) treatment effectiveness data that are important to client and regulatory requirements, and 3) samples of vitrified product. The cost of treatability testing depends on the analytical requirements and test location.

Demonstration Testing at pilot- or large-scale may be performed if desired. It is recommended that large-scale demonstration testing be performed as the initial melt setting(s) of a continuing project (assuming the demonstration is successful). In this way, mobilization and demobilization costs can be minimized.

Remedial Design is performed prior to large-scale remediation or treatment processing. The client may choose to have remedial design performed by Geosafe or by others with Geosafe support. Remedial design includes preparation of project engineering and specifications related to regulatory compliance, site preparation, equipment mobilization/demobilization, processing operations, sampling and analysis, and complete work plans including health and safety planning.

Let Us Hear from You!

Developments in the GeoMelt vitrification technologies have proceeded at such a rapid rate since 1993 that it's difficult for observers and potential users to keep current on the status and capabilities of the technologies. For up-to-date information, contact us:

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